MAGNETIC STORMS.[1]

THE magnetic needle has been described with poetic licence as "true to the pole," and few, I suspect, are aware how little it deserves this reputation. The earliest known information on this point in England dates from 1580, when Boroughs, observing at Limehouse, found the needle to point $11\frac{1}{4}°$ to the east of geographical north. During the next $2\frac{1}{3}$ centuries it kept moving to the west, reaching its extreme position of $24\frac{1}{2}°$ to west of north in 1818. It has since retraced its path, and now at Kew points only a little more than 16° to west of north.

Besides this slow secular change, there are daily changes, which are continuously recorded at a number of observatories. At a complete station there are three magnetographs, recording, respectively, declination, horizontal force, and vertical force changes. In the Kew pattern instrument each magnetograph has a separate drum and a separate sheet of paper, but the three drums are driven by a single clock, and two days' traces are usually taken on the same sheet.

In some foreign types of magnetograph, *e.g.* the Eschenhagen, which was used in the National Antarctic Expedition of 1901–4, the three elements are recorded on one drum, but only one day's record is taken on each sheet.

In my subsequent remarks I am obliged to employ a term having more than one meaning. It will be simplest to explain these by reference to the familiar daily variations of temperature. Suppose that in March we record the temperature at Kew at every hour and take a mean value for each hour of the twenty-four from all days of the month. We shall then find a regular rise from a minimum, probably at 6 a.m., to a maximum, probably at 3 p.m., and then a gradual fall to the minimum. The difference between this maximum and minimum is known as the *range* of the regular diurnal inequality for the month. On individual days, however, the hours at which the highest and lowest temperatures occur will vary, and if we take the mean of the differences between the highest and lowest temperatures of each individual day, irrespective of the hour at which they occur, we get a totally distinct range, which I shall call the mean *absolute* range.

The absolute range in any element cannot be less, and must usually be considerably greater, than the range of the regular diurnal inequality. At Kew, for instance, the mean absolute daily range of declination derived from the eleven years 1890 to 1900 was 13·6′, while the corresponding range of the regular diurnal inequality was only 8·0′.

The range of the regular diurnal inequality varies with the season of the year. Table I. shows its amplitude in the case of the declination at Kew, Batavia, and the *Discovery's* winter quarters.

TABLE I.

Range of Regular Diurnal Inequality (Declination).

Station	Lat.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Kew ...	51° 28′ N	4′·9	6′·1	9′·1	10′·9	10′·7	10′·9	10′·6	**11′·0**	9′·5	7′·7	5′·4	**4′·5**	8′·0
Batavia..	6 11 S	4·2	**4·6**	3·6	2·9	2·4	**2·0**	2·3	3·2	3·8	4·5	4·5	4·2	3·0
Antarctic	77 51 S	58·6	69·6	47·4	35·4	**27·3**	28·1	29·2	35·8	52·6	45·5	60·1	**85·2**	45·5

Remembering that in the southern hemisphere June represents mid-winter, it will be seen that the range is in all cases larger in summer than in winter.

Allowance must be made for the fact that the disturbing force required to displace the needle 1′ out of the magnetic meridian is proportional to the horizontal component H of the local magnetic force. Now the values of H in C.G.S. measure, at the epochs to which the data refer, were 0·183 at Kew, 0·367 at Batavia, and only 0·065 at the Antarctic station. Thus the disturbing force required to produce a range of 1 at Batavia would produce a range of 2′ at Kew and of nearly 6′ at the *Discovery's* winter quarters; but, even allowing for this, the Antarctic range is much the largest of the three.

[1] From a discourse delivered at the Royal Institution on Friday, March 4, by Dr. C. Chree, F.R.S., Superintendent Observatory Department, National Physical Laboratory.

The great increase apparent as we pass from temperate to Arctic or Antarctic latitudes is even more conspicuous in the irregular movements, which, when sufficiently pronounced, are known as magnetic storms. This is illustrated by Table II.

TABLE II.

Absolute Ranges of Declination.

At Kew from 11 years				Antarctic (77° 51′ S.) from 2 years			
Percentage of Days when Range				Percentage of Days when Range			
0′–10′	10′–20′	20′–40′	over 40′	0′–30′	30′–60′	60′–120′	over 120′
31	57	11	1	7	22	32	39

As already explained, the forces required to displace the needle 1′ out of the magnetic meridian at Kew and 3′ out of the magnetic meridian at the Antarctic station are approximately equal. If, then, the disturbing forces at the two places were of similar magnitude, we should expect ranges of less than 30 in the Antarctic to be as common as ranges of less than 10′ at Kew, and ranges above 40′ at Kew to be as common as ranges above 120 in the Antarctic. This, it will be seen, is exceedingly wide of the mark. A single year's records in the Arctic or Antarctic is likely to supply as many large disturbances as the records of a generation in the south of England. This is one reason why so much importance attaches to continuous magnetic observations in high latitudes.

The daily amplitude of irregular magnetic changes, like that of the regular diurnal inequality, is variable throughout the year, but the seasonal variation is usually different in the two cases. This is shown by Table III.

TABLE III.

Annual Variation in Inequality and Absolute Declination Ranges at Kew, omitting Highly Disturbed Days (1890–1900).

	Winter	Equinox	Summer
Inequality range	5′·25	9′·30	10′·80
Absolute range	10·35	13·81	13·56

Each of the three seasons contains four months, March, April, September, and October being included under "Equinox."

If the days of large disturbance, averaging nineteen a year, had been included in Table III., the preeminence of the equinoctial value of the absolute range would have been greater. Kew, it should be added, is fairly representative of all stations in temperate latitudes.

When we pass to days of large disturbance, the prominence of the equinoctial season in temperate latitudes becomes accentuated. This is shown by Table IV., which gives the seasonal distribution of the 721 magnetic storms recorded at Greenwich from 1848 to 1903, as calculated from the lists drawn up by Mr. W. Ellis and Mr. E. W. Maunder, with corresponding results for Batavia from 1883 to 1899, obtained by Dr. Van Bemmelen.

TABLE IV.

Seasonal Distribution of Magnetic Storms.

Place	Epoch	Percentage of all Recorded		
		Winter	Equinox	Summer
Greenwich	1848–1903	32	42	26
Batavia	1883–1899	33	35	32

Out of every 100 storms recorded at Greenwich, forty-two occurred in the four equinoctial months.

The seasonal variation seems to diminish as we approach the magnetic equator, and but little remains of it at Batavia.

When we pass to high latitudes the preeminence of the equinox as a season for magnetic storms seems to disappear entirely. This is shown by Table V., which compares declination results at Kew and at the *Discovery's* winter quarters.

TABLE V.

Percentage of Days having Range above 20′ at Kew, and above 120′ at the "Discovery's" Winter Quarters (77° 51′ S.).

Station	Mid-Winter	Equinox	Midsummer
Kew	12	16	9
77° 51′ S.	24	31	81

At Kew, out of every 100 days at midsummer (May to July), only nine had an absolute range above 20′, the corresponding figure for the four equinoctial months being sixteen, or nearly double; but in the Antarctic eighty-one out of every 100 days at midsummer had a range exceeding 120′, while the corresponding figure for the equinoctial months was only thirty-one.

The phenomena of magnetic storms appear, at least at some stations, to be largely influenced by the hour of the day. Table VI. gives some figures for Greenwich derived from the hours of beginning and ending in Mr. Maunder's lists for the years 1848 to 1903, as well as some figures which Dr. Van Bemmelen has given for Batavia.

TABLE VI.

Diurnal Variation in Magnetic Storms.

Station	Local time	Percentage of Total Occurrences		
		1–8 p.m.	9 p.m.–4 a.m.	5 a.m.–noon
Greenwich ...	Beginning	60	22	18
	End...	9	45	46
Batavia ...	Beginning	30	25	45
	End...	18	55	27
	Maximum intensity	33	43	24

At Greenwich no less than 60 per cent. of the storms commenced during the eight hours 1 to 8 p.m., while only 9 per cent. then ended.

There is yet another influence on magnetic changes which requires to be considered, viz. sun-spots.

TABLE VII.

Connection between Sun-spot Frequency and Declination Ranges.

Year	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
Sun-spot frequency (Wolfer)...	7·1	35·6	73·0	**84·9**	78·0	64·0	41·8	26·2	26·7	12·1	5·5
Diurnal inequality range—											
At Kew	7′·3	8′·5	9′·8	**10′·7**	9′·8	9′·5	8′·5	7′·8	7′·6	7′·3	6′·8
At Pavlovsk ...	6·3	7·3	8·7	**9·6**	8·6	8·2	7·4	6·8	6·3	6·0	6·2
Absolute daily range—											
At Kew	10·7	13·7	**17·7**	15·6	16·5	15·6	14·5	12·1	12·3	11·3	9·2
At Pavlovsk ...	12·1	16·0	**21·0**	17·8	20·4	18·1	17·5	14·6	14·7	13·1	10·5
At Pavlovsk—											
Mean range in month	28·2	46·3	**93·6**	48·3	84·1	47·4	52·4	43·8	46·6	38·3	32·8
Total range in year	42·1	92·3	**194·0**	87·1	145·6	73·9	88·7	101·1	118·9	63·8	94·2

While Prof. Wolfer's figures are given in Table VII. as a measure of sun-spot activity, it may be added that closely parallel results would be derived from the Astronomer Royal's figures for sun-spot areas. There was a well-marked maximum in 1893. The remarkable parallelism between the changes in sun-spot frequency and in the diurnal inequality ranges appeals to the eye.

Passing to the absolute daily range, we have a quantity which is considerably influenced by magnetic storms. Here, again, the ranges in the years of many sun-spots are conspicuously the larger, but the parallelism with sun-spot frequencies is less close. 1893, the year of sun-spot maximum, shows at both Kew and Pavlovsk a distinctly smaller absolute range than either of the adjacent years, especially 1892. Of the last two lines in Table VII., the first gives the arithmetic mean of the differences observed at Pavlovsk between the extreme positions of the compass needle during each month of the year, while the second gives its total range during the year. In both cases 1892 occupies the premier, and 1894 the second, position. 1893 lags far behind; in the case of the annual range it even follows 1900, which had the smallest sun-spot frequency of the whole eleven years. The close parallelism visible between sun-spot frequency and the regular diurnal inequality becomes more and more obliterated as we pass from the regular to the less regular, and from these to the highly irregular daily changes of terrestrial magnetism.

A general parallelism between sun-spot frequency and the range of the regular diurnal inequality is far from proving any intimate connection between the two phenomena on the same day. Table VIII. gives the results of an attempt to find out whether the parallelism extends to individual days' results.

TABLE VIII.

Relation of Sun-spot Area (Greenwich) to Absolute Declination Range (Kew) on same Day and on Three Subsequent Days.

	Algebraic excess of range over mean from all days							
	10 days (each month) of largest spot area				10 days (each month) of least spot area			
	Same day	1 day after	2 days after	3 days after	Same day	1 day after	2 days after	3 days after
11-year mean	+0′·17	+0′·25	+0′·48	+0′·53	−0′·32	− ′·45	−0′·38	−0′·35
1894	+1·23	+1·55	+1·61	+1·69	−1·44	− ·92	−1·62	−1·36
1895	−0·85	−0·22	+0·06	−0·17	+1·19	+1·4	+1·29	+0·92

The days of each month were divided into three groups. The first group included the ten days in which the Greenwich sun-spot areas were the largest, the third group the ten days in which they were least. If any close parallelism existed between the solar and magnetic phenomena on the same day, we should expect the mean of the absolute declination ranges from the first group of days to be much larger than the mean for the whole month, and that from the third group to be much less. Taking all the months of the years 1890–1900, there is a difference in the direction indicated, but it is exceedingly small.

To provide for the possibility that the solar influence takes one or more days to travel to the earth, mean declination ranges were formed, not merely for the ten days of largest or smallest sun-spot area, but also for the ten days immediately following these, for the ten days separated by two days, and yet again for the ten days separated by three days, from the days constituting the sun-spot groups. The results appear in Table VIII., and are somewhat more favourable for an association between the magnetic phenomena and the solar phenomena two or three days previously than for an association between the phenomena on the same day. Individual years, however, *e.g.* 1894 and 1895, give conflicting results.

In the preceding discussion declination has been chiefly referred to, because it is the most familiar element. In some respects, however, declination records during magnetic storms are inferior in interest to those of horizontal force. Fig. 1 shows two successive days' records—November 12–14, 1894—of this element at Kew. The first day's trace, which was quiet, helps to bring out two important features. A little after 2 p.m. on November 13 there is a very small decrease of force (downward movement), followed by a much larger increase. These sudden commencements to storms are not unusual, and seem to occur simultaneously all over the earth. The type at most stations is very similar. The initial slight fall in force is only sometimes seen; the rise is generally substantial. In the Antarctic the oscillatory character is unusually prominent.

By 8 or 10 a.m. of November 14 the disturbance is

practically over, but the force shows a marked depression compared to its value at the same time on the previous day. This is a very common after-effect of magnetic storms; the greater part of the depression usually disappears in two or three days. Fig. 1 is a good example of an ordinary disturbance in which the magnetic changes, though considerable, were seldom rapid. It differs conspicuously in this respect from the recent great storm of September 25, 1909. Many of the movements on this occasion were too rapid to be shown clearly in the photographic traces.

Dr. Schmidt, the leading German authority on our subject, assigns to this recent storm the first place of all recorded since the Potsdam Observatory came into existence some twenty years ago. Table IX. gives his estimate, on an arbitrary scale, of the intensity of the seven largest storms recorded at Potsdam.

Table IX.

Dr. Ad. Schmidt's Estimate of Intensity of Magnetic Storms.

Date of Storm	Disturbance at Potsdam	Date of Storm	Disturbance at Potsdam
September 25, 1909 ...	3800	September 11, 1908...	1520
October 31, 1903 ...	2860	August 20, 1894 ...	1410
February 14, 1892 ...	over 1800	February 9, 1907 ...	1340
July 20, 1894	1580		

An old question which has received a good deal of recent attention is whether there is a cyclic period approaching a month in the occurrence of magnetic storms. J. A. Broun, an early pioneer of magnetic work, believed his observations to indicate a period of about twenty-six days. From an elaborate study of many years' storms at Greenwich, Mr. E. W. Maunder deduced a period of 27·275 days, and Mr. Arthur Harvey independently, from a study of storms at Toronto, deduced the remarkably similar period of 27·246 days. The latest result of this kind is due to the eminent German magnetician already mentioned, Dr. Schmidt, who believes in a period of 29·97 days. Schmidt found evidence of this period in a number of recent storms, and he declares that it exists in the case of very large storms even when separated by many years. He found that the dates of occurrence of five out of the seven largest storms recorded at Potsdam (see Table IX.) could be deduced to a high degree of accuracy from the expression $2410,000+3031\cdot0+n\times29\cdot97$, which counts time in days from the commencement of the Julian era.

Fig. 2, which serves as a chronicle of magnetic history at Kew from August 20 to November 16, 1909, will illustrate some of the difficulties in the way when one attempts either to prove or disprove the existence of a period in magnetic storms.

The upper curve shows the value each day of the absolute declination range at Kew, the lower the value at each midnight of the horizontal force. We see incessant variations from day to day, and the number of days in which the declination range conspicuously overtops the average is considerable. During these days there is usually a distinct fall in the horizontal force, a circumstance also indicative of magnetic disturbance. The following days were considerably disturbed:—August 29, 30, September 21, 25, 30, and October 18, 19, 23, 24; while a variety of other days, *e.g.* August 31 and October 2, 8, and 9, were decidedly more disturbed than the average. If we associate August 30 and September 25 we get a twenty-six-day period; if we associate August 29 and September 25, or September 21 and October 18, we get a twenty-seven-day period; if we associate August 31 and September 30 we get a thirty-day period; and we have any number of other possible combinations left. Disturbed conditions are seldom limited to a few hours of a particular day, and often extend over two or more days. Thus there is usually a good deal that is arbitrary in the value deduced by observation for the interval between two specified storms.

The disturbances of September 21, 25, and 30 led to a fall in the horizontal force, from which it is doubtful whether the element had entirely recovered even by the middle of November.

Mr. Maunder and Dr. Schmidt both associate their periods with that of the revolution of the sun relative to a point on the earth. This period exceeds the true period of the sun's rotation—which varies considerably with solar latitude—because the earth is travelling round the sun in the direction in which the sun rotates.

The view most in favour at the present time is that magnetic storms are due to some solar discharge, probably from sun-spot areas, and of an electrical nature. We

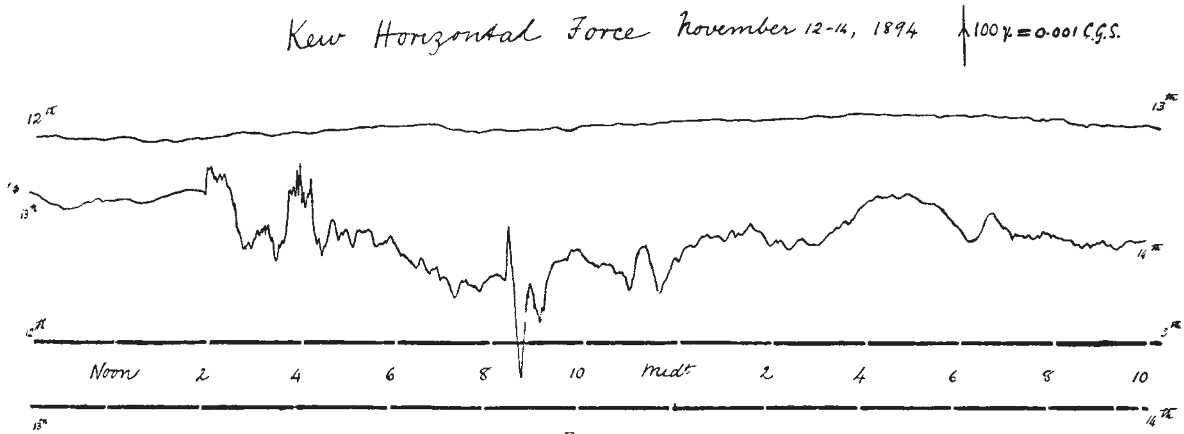

Fig. 1.

may suppose a solar discharge to traverse space like a jet of water; when it overtakes the earth a magnetic storm begins, which continues until the full width of the jet has passed over. If the solar discharge continues long enough, it may sweep over the earth during several successive revolutions of the sun, and so give rise to a series of magnetic storms at nearly equal intervals.

Theories accepting a solar origin for magnetic storms differ as to the nature of the solar discharge.

Nordmann has suggested Röntgen rays, Birkeland kathode rays, and Arrhenius negatively charged particles. On Nordmann's hypothesis the terrestrial phenomena should follow the solar in a few minutes, on Birkeland's hypothesis in a few hours, while according to Arrhenius the interval might be two days or more.

The most elaborate investigation hitherto made into the supposed solar origin of magnetic storms is due to Prof. Kr. Birkeland, of Christiania, who believes kathode or analogous rays to be the vehicle by which the solar disturbance is propagated to the earth. He has made numerous experiments with kathode rays in a vacuum tube which contains a miniature earth or "terrella." By means of electric currents in wires wound on the terrella, a magnetic field is produced similar in type to the earth's field. It was apparently his experiments that suggested his explanation of a certain type of magnetic storm which he terms the "equatorial." These "equatorial" disturbances are,

he says, normally largest in the earth's equatorial regions, where they consist mainly of a change in the horizontal force, but they are also well marked in temperate latitudes. The cause postulated by Birkeland is a circular electric current in the plane of the earth's magnetic equator, at a

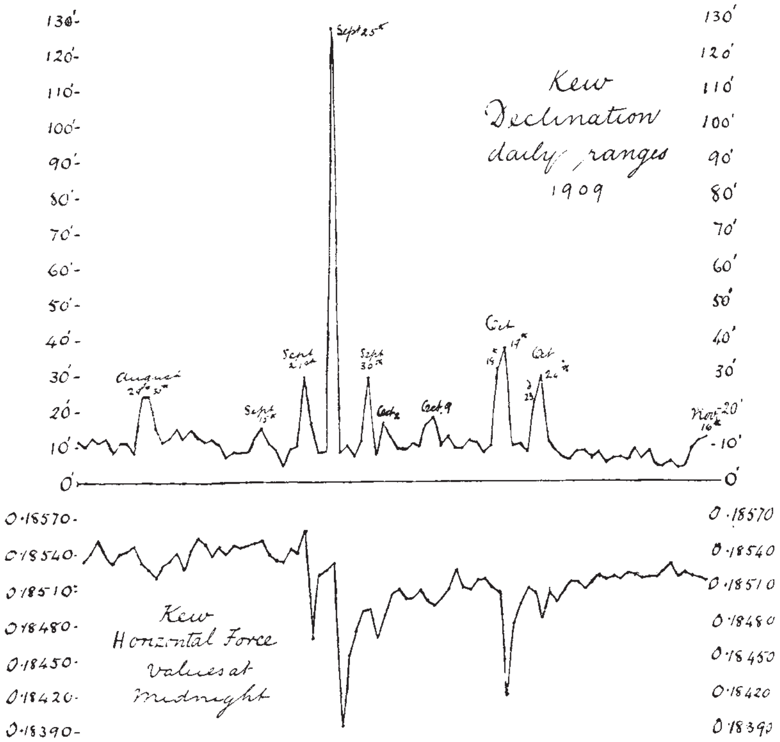

FIG. 2.

height of several thousand miles. An objection to this explanation is that, according to Prof. Carl Störmer's[1] analysis, it is impossible for kathode rays emanating from the sun to reach the earth's atmosphere at all, except in a narrow band round each magnetic pole. The larger the mass and the greater the velocity of the particle for a given electrical charge, the nearer can it approach the earth in the equatorial plane, and the larger is the radius of the zone surrounding each magnetic pole within which the particle can actually reach the earth. The β particles of radium, from their higher velocity, have more penetrating power than ordinary kathode rays, and are, in their turn, eclipsed by the α rays, the lesser velocity of which is more than compensated by their larger mass. According to Störmer, the greatest angular distance from a magnetic pole at which average kathode rays emanating from the sun can reach the earth is only 2·4°, while the corresponding angular distances for β and α rays are respectively 4·1° and 12·7°.

Undeterred by these mathematical results, Birkeland assumes that a type of magnetic disturbance, which he calls the "polar elementary" storm, is due to kathode rays from the sun which get within a few hundred kilometres of the earth's surface at considerable distances from a magnetic pole. The paths of approach and retreat are supposed to be radial, and the connecting part horizontal. These "polar elementary" storms were observed on a good many occasions at four temporary Arctic observatories provided with magnetographs, which Birkeland was

1 *Archives des Sciences physiques et naturelles*, Geneva, 1907.

able to keep in action during the winter 1902–3. The characteristics of "polar elementary" storms are their comparatively simple character and short duration, and the fact that their amplitude—unlike that of Birkeland's "equatorial" storms—is much larger in the Arctic than elsewhere. These storms have at least a general resemblance to a special type of disturbance[1] of which I found numerous examples in the records of the National Antarctic Expedition of 1901–4.

Birkeland found that frequently, after an "equatorial" storm had been in progress for some hours, one or a series of "polar elementary" storms intervened. He obtained copies of the curves taken at a number of observatories on the days of the disturbances recorded by his Arctic stations, and he has reproduced these with his own records in a most valuable series of plates published in his recent monumental work, "The Norwegian Aurora Polaris Expedition, 1902–3," vol. i.

Whilst recognising to the full the devotion with which Prof. Birkeland has prosecuted his investigations into magnetic storms for more than a decade of years, and while admiring the beauty of his experiments, I have to admit that I do not find his explanations convincing. If "equatorial" storms are due, as he believes, to electric currents at great heights above the earth in the magnetic equator, the disturbing force, while approximately horizontal and in the magnetic meridian at places near the magnetic equator, should, even in temperate latitudes, have a considerable vertical component, and near the magnetic poles the vertical component should largely predominate. I am unable to see these phenomena in the curves of Birkeland's own plates. Further, during the time of Birkeland's Arctic expedition the *Discovery* was at work in the Antarctic, and the simultaneous results obtained there do not seem capable of explanation on his hypothesis.

Fig. 3 affords one out of a number of examples of this.

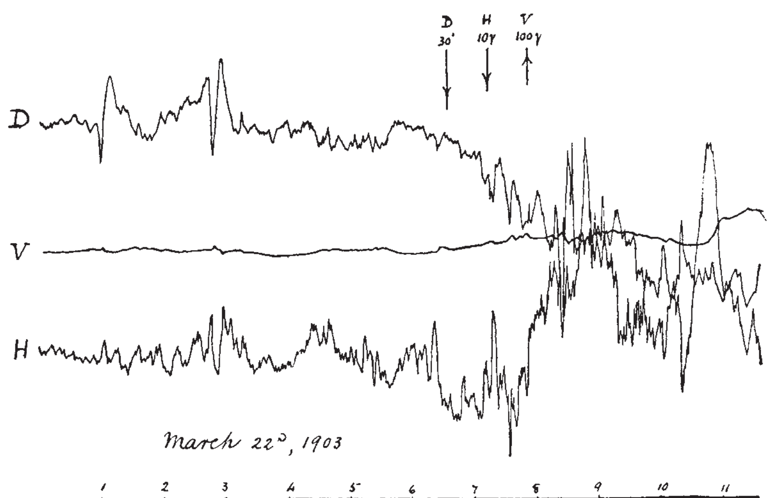

FIG. 3.—Magnetic Storm in Antarctic.

It shows the declination (D), vertical force (V), and horizontal force (H) traces at the *Discovery's* winter quarters on March 22, 1903, during a magnetic storm which forms

1 "National Antarctic Expedition, 1901–4." Magnetic Observations, p. 186.

the subject of Birkeland's Plate xx. Birkeland's curves, representing stations from 77° 41′ N. to 43° 32′ S. lat., all show two small but singularly distinct movements at about 1 p.m. and 2.45 p.m. G.M.T. These he ascribes to an "equatorial" storm. Now if these storms were due, as he supposes, to an overhead current in the plane of the magnetic equator, the vertical force disturbance, as we have seen, ought to have been largely predominant at the Antarctic station, which was only about 400 miles from the south magnetic pole. This is exactly what did not happen. Two movements occur in Fig. 3 exactly synchronous with those elsewhere, but the vertical force movements are much smaller than those in declination, and the disturbance in the horizontal plane is not smaller, but much larger than at the equatorial stations.

Interest also attaches to the large oscillation in vertical force between 9.30 and 11.30 p.m. G.M.T. with the accompanying considerable movements in the other elements. This is precisely the time of a "polar elementary" storm recorded at Birkeland's Arctic stations. A similar coincidence occurred on so many occasions that one can hardly suppose it to be accidental. This suggests a very intimate connection between magnetic phenomena in the Arctic and Antarctic.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. J. H. Jeans has been appointed Stokes lecturer in mathematics from midsummer, 1910.

Mr. W. B. Alexander has been appointed to the office of assistant to the superintendent of the museum of zoology.

The third annual report of the Forestry Committee refers to the work carried on during the past year. In June last the reader, Mr. A. Henry, commenced a series of experimental sowings of the different kinds of elms, which have yielded interesting results, showing that what were supposed hitherto to be varieties of one species, of unknown origin, are in reality combinations of two species, in which the Mendelian ratios are observed. Incidentally, these experiments have directed attention to the astonishing vigour displayed by certain first-crosses in trees, all of which hitherto had arisen in the wild state. An attempt is being made this year to produce artificially similar hybrids in the case of the more valuable kinds of trees, and for the first time, almost, the production of new breeds of forest trees is being tried. A plot on the University farm has been assigned by the Agricultural Department to the reader for forestry experiments, and about 5300 seedling trees, of known pedigrees, are now planted out. A small plot of *Eucommia ulmoides* has been established near Norwich. This tree, which was discovered in the mountains of central China, is perfectly hardy and fast in growth in this country. Its bark produces 5 per cent. of rubber, the quality of which, however, is still a matter of doubt, as only minute quantities have been tested.

GLASGOW.—In order to meet the necessity for increased teaching power in the faculty of arts, the University Court has decided to establish eight new lecturers and assistants in mathematics, natural philosophy, and the several literary and philosophical departments. A separate course in mathematics for students of engineering will be instituted, and better provision will be made for the tutorial instruction of students in smaller classes than have hitherto been practicable.

The annual report of the museums committee testifies to a considerable amount of work in the cataloguing and arranging of the collections under the care of Profs. Graham Kerr and Gregory. Gifts of entire collections, associated with the names of David Ure, Webb Seymour, and Mackenzie, have enriched the geological museum.

At the observatory a new house has been erected for the fine Corbett equatorial.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting M. Émile Cartailhac for the degree of D.Sc. *honoris causa* on May 10:—

"Nulli profecto ex eis qui hodie hominum naturae student posthabendus est Aemilius Cartailhac. Qui vir annos viginti quattuor natus commentarios in hoc genere apud Gallos eo tempore maximi habitos, in quibus gentium incultarum mores et vetustatis obsoletae reliquiae tractabantur, edendos suscepit. Quo munere viginti annos functus, cum res ex omni parte terrarum allatas scrutaretur, cum in ea loca ubi eiusmodi monumenta invenienda sunt ipse multas peregrinationes faceret, adeo incendit civium suorum studia ut diversis auctoribus quasi symbolam conferentibus maxima illa Acta conflata sint, quibus edendis ipse multos annos praefuit, quibusque etiam nunc curam impertit. Academiarum quoque Gallicarum rectoribus persuasit ut discipulos in his rebus institui iuberent: ipse Tolosae in sua urbe atque Academia iuniorum studia dirigit. Nihil profecto his diebus magis admirati sumus quam rudes illas picturas in cavernis ubi habitabant homines pristini inventas. Huiusmodi monumentis, quibus maxime abundant Hispania septentrionalis et australis Gallia, hic noster maximam operam dedit, eademque pulcherrime expicta in medium protulit. Iure igitur hic vir tanta doctrina ornatus, scientiae tam deditus, apud cives suos iamdudum nobilis, ubicunque homines haec studia colunt insigni laude celebrandus est."

The first Halley lecture was delivered on May 10 by Dr. Henry Wilde, F.R.S., the founder. The subject of the lecture was "Celestial Ejectamenta." Dr. Wilde maintained that comets originated within the solar system, being the result of explosive discharges from planets, especially the larger planets, in process of cooling.

The Romanes lecture, postponed from May 18, will be delivered by ex-President Roosevelt on Tuesday, June 7. The subject is "Biological Analogies in History." The honorary degree of D.C.L. will be conferred on the lecturer on the same occasion.

The honorary degree of D.Sc., as already announced, will be conferred on Messrs. P. H. Cowell, F.R.S., and A. C. Crommelin, of the Royal Observatory, Greenwich, on Saturday, May 21.

AMONG many other matters of interest dealt with in the second volume of the report of the U.S. Commissioner of Education for the year ended June 30, 1909, special attention may be directed to the gifts and bequests made during the year to promote higher education in America. The total value of all benefactions recorded as having been received by the 606 universities, colleges, and technical institutions reporting to the Washington Bureau in the year under consideration amounted to about 3,561,000*l*. Of this amount, 806,000*l*. was given for buildings and improvements, and 2,244,000*l*. for endowment, the remainder being for current expenses. Thirty-six institutions each received 20,000*l*. or more, and together accounted for 1,972,000*l*. of the above total. Yale University, Connecticut, was helped most generously, having received some 254,600*l*. The University of Virginia was credited with about 157,500*l*., while the University of Chicago, Illinois, Grinnell College, Iowa, Bowdoin College, Maine, and Washington University, Missouri, each received 100,000*l*. or more. We notice that the 606 institutions referred to employed a teaching force of 26,369, and had an aggregate enrolment of 308,163 students. Of the 606 institutions, 89 are under the control of States or municipalities and 517 are managed by private corporations. It will be noticed that several prominent universities supposed to have received very large gifts during the year are not mentioned in this summary of the official record of benefactions. The Commissioner of Education points out that official statements of the amounts reported to have been received could not be obtained by the Bureau at Washington.

IN the issue of *Science* for April 29 Prof. Guido H. Marx publishes a table showing the attendance of students at American and foreign universities during the session 1906–7. The figures of attendance were furnished to the U.S. Commissioner of Education by the editor of "Minerva." Prof. Marx recognises the probability that the totals he gives may understate, rather than overstate, the attendance in some of the countries which have not